EXTENSION OR FLEXION FOR THE LUMBAR SPINE[1]

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One of the most common conditions referred for physiotherapy is low back pain and yet I suppose there would be few of us who have any clear-cut idea on the relative place of flexion and extension exercises in its treatment. Similarly, I suppose few of us who have read overseas literature on the subject have not been confused by the differences of opinion expressed as to whether people should be taught to stand with a flattened lumbar curve or not, or whether a patient should be rested with a lumbar pillow or with the knees supported in Fowler's position to allow the lumbar curve to flatten. The problem can be divided into two parts, one dealing with the treatment of pain and the other dealing with prophylaxis, and it is the latter which I will discuss first.

When a patient has been successfully treated for a bout of back pain, consideration is usually given to the prevention of recurrences. If the discussion is limited to the choice between extension and flexion, the problem must be considered in relation to building up muscle power and selecting postures for working, standing, sitting and lying.

PROPHYLAXIS

Muscle Power

The type of muscular support needed for a joint once it has been injured is threefold. Firstly the muscles must be strong, perhaps at a power greater than would be rated as a six on a muscle chart, to carry out heavy work without undue strain on the joint. Secondly the muscles must have very good powers of endurance to cope with the fatigue factor of daily routine. Thirdly the muscles must be capable of rapid strong contraction when a sudden unexpected strain is thrown on the joint.

Whenever any joint is sprained, there is a resulting weakness of one or more of the muscles which support it, and if specific exercises are not done to restore the full power, a slight degree of weakness will remain. This slight loss of power in no way hinders the normal functioning of the joint but it becomes important when the joint is subjected to another spraining force. With the slightly lessened muscular protection, less force is needed to re-sprain the joint. These circumstances are readily seen when closely observing sprained and recurrently sprained ankles. It is less easily appreciated in the lumbar spine with its multiplicity of joints and deeply placed intrasegmental muscles. Obviously the larger supportive muscles of the lumbar spine must play some part when the back is painful but it is the shorter muscles, acting on one intervertebral joint, which play the important part.

Restoration of power of muscles supporting a synovial joint, lost as a result of a sprain, is quite a rapid process once the pain has subsided, requiring only two to four weeks of concentrated exercise. However with the intervertebral joint the state of the disc can be such that muscle power cannot be increased, even at a comparatively painless stage, and whether this will be the case with a particular patient can only be determined by trying to do the exercises.

Although the weakness which results from a sprained joint does not completely recover without exercise, it is unnecessary to subject all people with sprained joints to a period of set exercises, particularly following a first sprain. Once patients are free of pain, only a very small percentage of them (people being what they are) will do exercises sufficiently effectively for them to be of value. However when a more severe sprain closely follows an earlier sprain, the exercises are essential and most patients, but not all, would see the purpose and value of doing them and would therefore be likely to do them effectively.

In the case of the lumbar spine, the resultant weakness is mainly in the intraseg-

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mental muscles because they are the particular antigravity muscles associated with the one intervertebral joint, a point to be referred to again later, and therefore they are the muscles which have given way or failed to support the joint. To restore this loss of power, extension exercises are required. This is a point in favour of extension exercises.

Posture

How many of us have thought that in standing our abdominals are under continual static tension to prevent gravity pulling the lumbar spine into an extreme lordosis? If we stand and consciously relax our trunk muscles, most of us will feel the lumbar spine drop into kyphosis, indicating that our longitudinal back muscles must have been under tension to prevent the lumbar curve from flattening. Asmussen and Klausen (1962) found, when testing the abdominal muscles and the longitudinal back muscles electromyographically in a normal standing position, that in 80% of the people tested, the extensors were the only muscles showing activity. In other words, the extensors are of greater importance when considering the muscular support of the lumbar intervertebral joints in normal standing in 80% of the population. When this function is related to the re-education of the extensor muscles, emphasis should be placed on endurance rather than on power.

Nearly all our daily tasks require us to work forward of our centre of gravity and most of them involve bending or remaining in a bent position. Obviously under these circumstances, the majority of the supportive muscular work falls on the extensors of the lumbar spine and not on the flexors. From a muscle power point of view for the patient who has had trouble with his lumbar spine, emphasis must be placed on the lumbar extensors. If we now add a load to any of these daily functions, for example moving furniture, lifting heavy objects, etc., the muscular activity must increase in proportion to the work being done. All of the muscles round the joint will contract to do the work and hold the joints stable but the antigravity muscles must have the greater work to do.

One feature, which occurs only in the joints of the lumbar spine, is the role of the abdominal muscles in reducing the load placed on those joints by raising the intra-abdominal pressure. They convert the abdominal cavity into a cylinder which mechanically supports some of the load. Consider a man in the standing position holding a weight in his hands. If his abdominals do not contract the weight is transmitted through his arms, spine and legs to the floor. However, if his abdominals contract and convert the abdominal cavity into a weight bearing cylinder, the weight which would have been taken through the spine will be distributed between the spine and the abdominal cylinder. Nachemson and Morris (1964) discuss this in detail. The abdominal muscle work is a static contraction which is balanced with the degree of contraction required for its action as a stabilizer of the lumbar intervertebral joints against the activity of the extensors. Heavy activities call for strong flexors and extensors but the extensors are the agonists or prime movers and the movement which occurs under the load is one of extension. The work of the extensors is therefore greater than the flexors and in re-educating muscle power the emphasis must again be placed on the extensors.

The only work requiring a greater effort by the flexors than the extensors are fixing ceilings or being "bottom man" in an acrobatic balancing act. As the trunk is arched backwards the centre of gravity moves behind the peak of the lumbar lordosis making the abdominals the antigravity muscles. While in the position required by such jobs the abdominals have to act as antigravity muscles and prime movers as well as working to build up intra-abdominal pressure, while the extensors only work as antagonists if they work at all.

Dubansky and Larson (1957) consider that the ratio of back extension muscle power to flexion muscle power should be in the proportion of three to one and they consider that any increase of that proportion would eventually result in mechanical backache. In another article, Larson (1959) says that he has often found the proportion as high as six to one. On these grounds he considers that the abdominals must be of first importance when building up power and that as well as restoring the balance between the abdominals and the extensors, the power of both must be increased but that this should not be attempted until the patient is pain free. I feel the survey which he conducted related the long flexors

to the long extensors and did not necessarily take into account the state of the short intrasegmental muscles at the site of the faulty joint. A patient may have quite strong longitudinal back muscles and yet a weak section of intrasegmental muscles. When such a patient, lying prone, is asked to lift and hold his trunk extended for a long time while his feet are stabilized, as fatigue sets in, the lumber spine can be seen to sag slightly at one intervertebral level without the long back muscles seeming to let go.

To summarize at this stage, eighty per cent. of people with lumbar symptoms would need, from a postural point of view, to build up the power of extensors. For normal daily living, emphasis must be placed on the extensors except for those who do heavy overhead work. For almost all heavy work, although we need strong abdominals, the greater emphasis must again be placed on the extensors. Finally, and of greatest importance, the extensors must be built up to overcome weakness following recurrent joint sprain.

The important functions of the muscles were stated as power, endurance and briskness of action. The exercise which builds power is one which uses a small number of repetitions and maximum resistance. When endurance is the requirement, the exercises should use heavy resistance but with either a high number of repetitions or prolonged periods of static contraction. What then is the number of repetitions dividing power building from endurance building? More than three to five repetitions with maximum resistance will introduce endurance to an extent which lessens the effectiveness of building power. However for those who feel five repetitions are too few to give as a routine of exercises for a patient, it is perhaps reasonable to ask him to attempt three groups of five repetitions allowing short rests between each group, although even then endurance becomes an important factor: also, the likely gain is hardly worth the extra effort involved.

The ability of a muscle to contract rapidly in emergencies is difficult or impossible to re-educate alone because it is a quality which cannot be effective in a muscle which is not strong or one which tires readily. It is also dependant on a state of mental alertness and efficient neural activity. Despite these factors, it is possible to awaken or stimulate such muscle function by exercises of a very short range done as short snap movements under maximum resistance with very few repetitions; the exercise must be possible even when the muscle is fatigued.

While there is so much activity the world over in regard to exercises of various types and patterns, one may be excused for treading with trepidation when suggesting exercises which are out of pattern. However the ones to be described are chosen because of their simplicity, their ready variability for the tiny weak female or the burly "health through strength" male, their easy adaption for home use and because they only take about two minutes to do.

(1) The patient, lying face down on a couch, grasps the couch at shoulder level with his hands approximately shoulder width apart. If the kitchen or dining-room table is too wide or if it is round the position can be achieved by having the chin over the edge of the table and the hands holding on either side of the chin. The patient then extends both straight legs as high as possible and holds them at his maximum range. After holding for approximately two seconds he makes four or five snap lumbar extension snatches not allowing his legs to sag any lower than his maximum holding position. Following these snatches, he may lower his legs slightly or keep them at his maximum holding position for ten seconds. The lift is then repeated holding momentarily before repeating the snatches. The cycle is repeated three times in all and the legs do not return to the table until after the third ten-second hold.

(2) The second exercise is done on the floor with his feet stabilized, for example under the lounge and his hands clasped behind his head. He then repeats the same pattern but by extending his trunk instead of his legs.

These two exercises should be repeated three or four times a day. Obviously the exercises need to be graded during the first two or three days before maximum effort can be anticipated. When it is necessary to aim for an extraordinarily high degree of muscle power, the two exercises can be made harder by using weights and by moving through a greater range, starting from a position of

trunk flexion and lowering again to the trunk flexion position after the ten-second hold each time. However it is rarely necessary to go to these extremes.

Resting and Working Positions

A patient often requires instructions as to how to care for his back, and literature on the subject contains widely opposing views of what he should be taught. I will discuss some of the more common aspects such as positions for sitting, sleeping, working at ground level and lifting.

Williams (1955) considers that the correct position for sitting is one which has a trunk-thigh angle of less than 90° to produce a flattening of the lumbar curve. When a person sits in a straight chair, he should sit with crossed thighs so that the top thigh forms an angle of less than 90° with the trunk. He considers it incorrect to sit in the same chair and not cross the legs as the angle would be 90° or more and would allow the lumbar spine to lordose. If we now refer to Cyriax (1954) we will see that his emphasis is on creating a lumbar lordosis in sitting. If we compare the work of these two authors in relation to lying positions, Cyriax again places emphasis on the lumbar lordosis and suggests using the prone lying position, while Williams considers this position wrong and suggests that the patient would lie on his side with both hips and knees slightly flexed. For those who advocate flexion in functions such as weeding or polishing, shovelling or lifting, Weider (1958) states that there must be a strong voluntary contraction of the abdominal muscles to hold the lumbosacral joint flexed when load is placed on the spine by the work being done. During the action of lifting an object from the floor, this strong contraction of the abdominal muscles is done to prevent extension of the lumbosacral joint, which is where he believes the first extension movement normally takes place, so safeguarding the disc from extension injury while it is being subjected to increased pressure. Cyriax stipulates that the lumbar spine must be lordosed while taking the weight of the object. The position for weeding, described by Cyriax as being on all fours with the weight forwards on one hand while the other hand does the work is frowned upon by Weider. He recommends the position of sitting back on the haunches, a position which Cyriax considers is bad.

The two main points to be considered when choosing between the various postures are firstly, that the work given to the joints should be minimized as much as possible and secondly, that the joints should, whenever practicable, be maintained in a position midway between all ranges. Keegan (1953) went to great lengths to investigate the ideal sitting position and his findings resulted in a chair which gives support slightly lordosing the lumbar spine and allows an agle of approximately one hundred and thirty-five degrees between the trunk and the thigh. The angle of one hundred and thirty-five degrees is the one which permits the lumbar vertebrae to relax midway between full flexion and full extension. This is the answer to the opposing views mentioned earlier. The position of the legs should not adversely affect the position of the lumbar vertebrae, and the lumbar spine should be supported to prevent it from sagging into flexion due to gravity without however forcing it into full extension. Lying with slightly flexed hips and knees is the position of choice for sleeping because the legs in this position do not interfere with the resting position of the lumbar spine. The prone position usually produces too much extension unless a small lower abdominal pillow is used. A suitable type of mattress is one which does not sag, and yet allows the pelvis to sink sufficiently for the lumbar spine to be supported in its mid position. If this proves difficult to obtain with an innerspring mattress, it may be necessary to have a thin flock overlay on top of the innerspring mattress as the pelvis can be burrowed into the overlay more easily. As for weeding, the position suggested by Cyriax is the one of choice because the lumbar spine can relax in mid position.

Concerning lifting there are three factors which must be borne in mind. Firstly, the amount of work which is to be transmitted to the lumbar spine should be reduced as much as possible by using the legs to save the back, by squatting and by levering the arms on the legs where possible. Secondly, the position of the lumber intervertebral joints should be balanced midway between all ranges. This is a position which is taken up naturally provided the above principles are followed; it

should not require any mental effort or contraction of any particular group of muscles such as is recommended by Weider. Thirdly, the muscles must be in an adequate state of contraction to cope with the load.

TREATMENT

Resting Positions

The resting position for the lumbar spine of a patient in pain is a different matter from that of the pain-free patient. Although the chosen position is still one which rests the lumbar spine midway between its ranges of movement, the mid position may not be the same as it would have been if pain were not present. Movement may be limited by pain in one or more directions and therefore the chosen position supports the lumbar spine midway between the painful limitations of flexion and extension. This is the reason why some patients gain relief from lying supine with a lumbar pillow as advocated by Cyriax and others require the position advocated by Williams which is similar to the old sagging bed, that is with the patient's trunk rested in a straight position with the hips and knees supported in some flexion. As symptoms recede and painful limitations of movement improve the position of rest can be reverted to normal.

Similar discussion applies to the type of corset a patient should wear when this becomes a necessary part of treatment. In South Australia, most corsets we see are ones which maintain a lordosis and limit flexion. Doctors who advocate flexion use a brace which prevents extension of the lumbar spine (e.g. Williams brace, frequently advertised in the American issue of the *Journal of Bone & Joint Surgery*). However the principle should be that the support is made to rest and maintain the lumbar spine midway between the painful limits of flexion and extension of the affected intervertebral joint. When steels are fitted in the lumbar area of the corset they should be curved to fit the patient and not shaped to force the lumbar spine into flexion or extension as so often seems to happen. A wrongly fitted corset can result in an increase in pain whereas it should relieve pain. Sometimes the reason a corset is successful in relieving pain is not that it is a flexion corset or an extension corset but rather that it is effective in the same way that a simple elastic corset or "roll-on" is often effective in relieving lumbar pain. Its effect is said by Morris *et al.* (1961) to be due to the fact that constriction of the abdominal contents makes it able to take some of the load which would otherwise be transmitted through the lumbar intervertebral joints.

Exercises

Before embarking on the detailed discussion of extension and flexion exercises in the treatment of patients complaining of pain of skeletal origin, let me clear up one point for those who may feel I am biased towards manipulative treatment and may expect me to believe that exercises have no place in the treatment of back pain, sciatica, *etc.* Although I believe that passive movements (including manipulation) should be used as a first approach in all, or nearly all, such patients because the method of treatment is so informative and quickly effective, I do not mean that the patient cannot be treated by exercises from the outset. Of those patients who are treated by passive movements, there are some who need the added help of exercises and there are a few who will respond only to active exercises. In relation to these active exercises, I would go even further and say that of those patients whom we can help only by means of active exercises, there are probably some who will only progress if the exercises include a rotary element. However the discussion in this paper is limited to simple flexion and extension exercises, although there is a possibility that the rotary element can sometimes correct a valueless flexion or extension exercise into an effective one.

My feelings on the relative place of flexion or extension exercises in the treatment of painful lumbar conditions are that in examples where symptoms arise from a synovial joint it is likely that either type of exercise will effect improvement but that the one which reproduces the pain if done too strongly is likely to be the most effective, and response to treatment is likely to be quite rapid. The same approach applies to a disc problem which has reached a chronic stage. However when dealing with an acute disc condition the exercises need to be kept at a stage of very little resistance and the type of exercise chosen whether it is flexion or extension should not reproduce pain to any marked extent. Progress with treatment is likely to be slow.

A survey has been started on patients treated by flexion and extension exercises but the numbers recorded so far are too small to be more than a guide. In my private practice I have been able to gather only fourteen patients who would fit into this survey over a period of eight months and I would suggest, therefore, that this survey might be extended to the teaching hospitals and be conducted over a twelve-month or two-year period by the Society.[2] Attached is a copy of the questionnaire used and other details of the survey which could be used by the hospital physiotherapists.

Consecutive patients who met the following requirements and who were treated by flexion or extension exercises were recorded. All were required to have shown no signs of improving for a period of at least two weeks before exercises were commenced and their symptoms and signs had to fall into one of the following three groups:

Group 1

Patients who complained of low back pain which did not radiate to a level higher than the third lumbar vertebra and which was not accompanied by any protective spasm resulting in scoliosis or lumbar kyphosis.

Group 2

Patients who complained of low back pain plus referred pain radiating down the full length of the lateral and/or posterolateral aspect of the leg but not extending into the foot, nor radiating to the front or posteromedial aspect of the leg. Any patient who had a protective spasm resulting in deformity or who had neurological changes was excluded from this group.

Group 3

Patients who complained of low back pain plus referred pain as described above but including the foot, and with neurological changes. Patients were not excluded if they had protective muscle spasm.

The patients within these groups were further limited by their onset. The type of onset included in the survey was limited to those caused by an activity which could not be considered out of the ordinary or where the symptoms began for no apparent reason. In other words, patients who had pain caused by a direct blow or a fall were excluded.

These three groups were chosen because they were considered to be among the most frequently referred for physiotherapy. The "no improvement" period insisted upon was required because of the natural processes of cure which exist. Although this requirement excludes the patients who may have improved without treatment it does not exclude those who may have continued to get better on their own once the initial move was made by treatment; even a control group would not provide this protection.

It seemed wise also to exclude from the survey any candidates who were favourable but whose environment or personality resulted in an excessive display of pain which rendered them poor witnesses.

The exercises used in the survey utilized the patient's body weight as the resistance and were begun as strongly as possible. The goal was for the patient to perform strong inner range movements without pain. Where an exercise caused an increase of pain which persisted for longer than half an hour, it was made easier either by lessening the resistance or by exercising in the outer part of the range.

SUGGESTED SURVEY

Conditions for Inclusion

To include a patient in the survey you must know the following:

1. That the symptoms came on spontaneously or following a trivial incident (exclude all falls and traumatic incidents).
2. That the symptoms and signs will fit one of the three groups:

   Group 1.—Back pain (below the level of L3).

   Group 2.—Back, posterolateral or lateral thigh and leg pain. (*No* foot pain. *No* spasm scoliosis or lumbar kyphosis).

   Group 3.—Back, posterolateral or lateral thigh and leg with or without foot pain.

   Plus neurological changes.

   With or without spasm or deformity.

[2]Physiotherapy Society of South Australia.

3. That there has not been any improvement in the patient's condition during the two weeks before the treatment by flexion or extension exercises began.
4. That he has not an excessively low threshold of pain.

From the initial examination you need to know:

1. In the case of Group 3 the details of neurological changes.
2. Whether the symptoms prevent work or sleep, and what the patient's work involves.
3. How long he had had symptoms before treatment began.
4. The limitations of flexion and extension assessed in the standing position.
5. The limitation, if any, of straight leg raising.
6. Whether the patient has had any treatment at all before treatment began and if so what it was and its effect on the condition.

During treatment, record details of exercises given and the effect they produce and when treatment is completed fill in the form provided and return to the head of your department.

Exercises

FLEXION EXERCISES

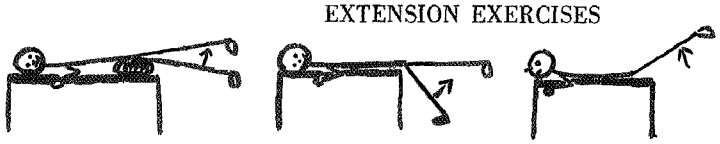
Stage 1 Stage 2 Stage 3

6-10 repetitions
4-5 times a day.

5 repetitions
3 times a day.

Stage 4
Final aim is to do both.

EXTENSION EXERCISES



Stage 1 Stage 2 Stage 3

6-10 repetitions
4-5 times a day.

5 repetitions
3 times a day.

Stage 4
Final aim is to do both.

Four stages for the exercises are shown. The first three are reasonably easy but they gradually increase in difficulty until the fourth stage, the final aim which includes two exercises using maximum resistance. Start with the exercises at the hardest stage possible provided they do not produce an aggravation of the symptoms which takes longer than half an hour to subside.

Two weeks treatment using either Flexion or Extension type exercises without producing improvement in symptoms or signs is sufficient time, for survey purposes, before changing treatment.

Suggested Questionnaire

Name..... Male ☐ Female ☐

Institution at which treated..... By whom treated .....

1. The patient was treated by Flexion exercises ☐
   The patient was treated by Extension exercises ☐
   The patient was treated by Extension and Flexion exercises ☐

2. Group One ☐ Group Two ☐ Group Three ☐
   Pain in foot ☐ Weakness of one muscle ☐ Weakness of two muscles ☐
   Weakness of more than two muscles ☐
   Give details of muscle weakness.
   Depressed knee jerk ☐ Absent knee jerk ☐ Depressed ankle jerk ☐ Absent ankle jerk ☐

3. Do symptoms prevent work? ☐ Yes ☐ No.
   Do symptoms prevent reasonable sleep? ☐ Yes ☐ No.
   Does patient do heavy manual work? ☐ Yes ☐ No.
   Give details of work.

4. Has the patient had the symptoms — 1 month ☐ 2 months ☐ 3 months ☐ 4 months ☐
   5 months ☐ 6 months ☐ longer than 6 months ☐

5. Assessment of movements before treatment.
   Flexion and Extension equally limited and painful ☐
   Flexion limitation greater than 50%. Extension full range ± slight pain ☐
   Flexion more limited or more painful than Extension ☐
   Extension limitation greater than 50%. Flexion full range ± slight pain ☐
   Extension more limited or more painful than Flexion ☐
   SLR is limited by more than 50% (either unilaterally or bilaterally) ☐
   SLR is between 50% and 75% (uni or bilaterally) ☐
   SLR is full or almost full and only slightly painful or painless ☐

6. Treatment.
   A.—Was the patient:
   (a) Completely relieved by Flexion exercises? ☐
   (b) Partially relieved by Flexion exercises? (i.e. further treatment required) ☐
   (c) Unchanged by Flexion exercises? ☐
   (d) Made worse by Flexion exercises? ☐

   Did the Flexion exercises have to be controlled because of pain ☐ Yes ☐ No.

   If yes, give details.

Was the patient able to do strongly resisted inner range Flexion exercises by the end of the treatment period? ☐ Yes ☐ No.

Was this result achieved in 1 day ☐ 1 week ☐ 2 weeks ☐ 3 weeks ☐ longer than 3 weeks ☐

B.—Was the patient:

(a) Completely relieved by Extension exercises? ☐

(b) Partially relieved by Extension exercises? (i.e. further treatment required) ☐

(c) Unchanged by Extension exercises? ☐

(d) Made worse by Extension exedcises? ☐

Did the Extension exercises have to be closely controlled because of pain? ☐ Yes ☐ No.

If yes, give details.

Was the patient able to do strongly resisted inner range Extension exercises by the end of the treatment period? ☐ Yes ☐ No.

Was the result achieved in 1 day ☐ 1 week ☐ 2 weeks ☐ 3 weeks ☐ longer than 3 weeks ☐

7. Other Treatment.

Had the patient had any other treatment which was unsuccessful or only partially successful and then had no further improvement before the survey period? ☐ Yes ☐ No.

If the answer is *yes,* please outline treatment and results.

Did the patient have any other treatment after the period of survey? ☐ Yes ☐ No.

If the answer is *yes,* please outline treatment and results.

SUMMARY

When considering prophylaxis for lumbar spine conditions in relation to flexion and extension exercises the extensor muscles, and in particular the intrasegmental muscles need greater attention than the flexors, but not to the exclusion of the latter. When recommending a posture for the lumbar spine in any particular function neither flexion nor extension should be dominant but the lumbar spine should be held, supported or rested midway between these ranges.

During the treatment of painful lumbar conditions the supporting or resting positions should be midway between the painful limits of flexion and extension for the affected joint. Regarding treatment by flexion or extension exercises it would seem that caution should be exercised when they increase pain but that in most cases it need not be classed as a contra-indication. A survey has been presented which may clarify the relationship of flexion and extension to various syndromes but its effectiveness or usefulness is open to doubt in view of the problems associated with diagnosis.

DISCUSSION

During the discussion which followed, Mrs. Burnell stated: Although I agree that exercises should be simple, variable and quick to do, I disagree most strongly with the practice of extension exercises for power, endurance and briskness, in inner range only. This is never the range of injury unless it happens to be a kind of whiplash driving injury. I feel that patients must learn to stabilize their backs in the middle range working the extensors strongly for power, endurance, and stability as well. However, the abdominals should be built up as well, particularly in the middle range again, with additional work for the abdominals and extensors together. The exercises should be started in the painless range and work towards the painful range gradually.

In regard to the survey, I feel that the exercises should include the rotary element from the first as back strains are usually rotary in character.

In reply Mr. Maitland said: I would agree that the rotary element is important and had only omitted it from the survey for the sake of simplicity. However, it would be quite easy to include more groups so that this element could be included.

I would agree in principle with Mrs. Burnell's first point that extension exercises constantly performed in their inner range can fail to increase power adequately in the essential range. However, if one increases power in the inner range, power in the other ranges will also increase. In practice, if a patient is unable to do exercises in the inner range because of increase in symptoms then outer range extension exercises are used.

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